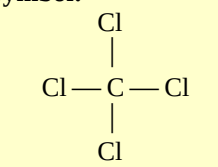
Carbon Tetrachloride

What Is It? Carbon tetrachloride, CCl_4, is a nonflammable man-made chemical that is produced as a liquid but evaporates easily in the environment and is commonly found as a gas. This colorless liquid with a sweet odor is slightly soluble in water. An organic compound, carbon tetrachloride stays in air for a long time, with a half-life of 30 to 100 years. (The chemical half-life is the time it takes half the initial amount to be broken down, e.g., by a photochemical reaction). When heated to very high temperatures, it decomposes to toxic phosgene and hydrogen chloride fumes.

Symbol: **CCl_4**



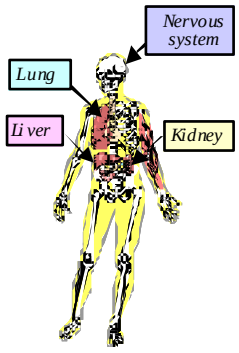
Molecular Weight: 154

How Is It Used? Carbon tetrachloride was widely used for decades as a cleaning fluid and solvent, including for degreasing equipment and machinery parts at facilities such as the Hanford Site. It was also used at the Hanford Site in the refining process during the separation of plutonium. In the past, carbon tetrachloride was commonly used in the dry cleaning industry and in homes as a spot remover and was also used to make refrigerator fluids and propellants for aerosol cans. It was also used in agriculture through the mid-1980s as a fumigant to kill insects in grain. Although carbon tetrachloride is still used in some industrial applications, its production is being phased out in this country and in many others because of concerns about its effects on the earth's ozone layer.

What's in the Environment? Carbon tetrachloride is widespread in the environment due to its extensive past use and persistence. It is slightly soluble in water and evaporates quickly from surface water and soil, so most is present in air. Worldwide, its concentration in air is about 0.1 parts per billion (ppb), while urban levels are higher at 0.2 to 0.6 ppb. It is often found in air inside buildings, with reported levels in U.S. cities ranging from 0.14 to 0.3 ppb. Carbon tetrachloride is present in many drinking water supplies, usually at levels less than 0.5 ppb. At the Hanford Site, the carbon tetrachloride used in the plutonium separation facility at the central part of the site was eventually discharged to the soil and has since reached the underlying groundwater.

Unlike many volatile compounds, carbon tetrachloride is quite stable in air. It does not readily dissociate in the lower atmosphere, nor is it readily washed out by rainfall. Only when it reaches the upper atmosphere above 20 kilometers does photodissociation become important. Similarly, carbon tetrachloride can remain in groundwater for a long time because in general, little is naturally degraded or oxidized or volatilized until brought to the surface. In soil and sediment it attaches to organic matter, preferring this phase 100 times more than water in settings with organic material. It does not appear to build up in plants or animals, including fresh and salt water organisms.

What Happens to It in the Body? Carbon tetrachloride can enter the body when someone takes in air, water, or food containing the chemical, and it can also be easily absorbed through the skin. When carbon tetrachloride is inhaled or ingested, much of it leaves the body within an hour or two in the air you exhale. Of the initial amount breathed in, 30 to 60% may be absorbed across the lungs and retained in the body, notably in body fat. The rest is removed primarily in the feces. Of the initial amount ingested, most (85% or more) is quickly absorbed into the bloodstream from the gastrointestinal tract, as 80 to 85% is exhaled beginning about 8 minutes after ingestion (as blood circulates to the lungs). About 4% of the amount that stays in the body is converted to carbon dioxide and exhaled, while the remainder is metabolized and then degrades with a half-life in the body of about one day. Most of what remains accumulates in fatty tissue such as the liver and may take several weeks to be eliminated from the body in urine or feces, either as carbon tetrachloride or as degradation products such as chloroform.



Organs and systems affected when CCl_4 is taken in through food, water, or air.

What Are the Primary Health Effects? Inhaling high concentrations (20,000 ppb or more) of carbon tetrachloride can affect the central nervous system, causing headache and dizziness often accompanied by nausea. If someone breathes air with levels ten times higher (200,000 ppb or more), the liver and kidney can be affected. In the liver, carbon tetrachloride causes fat to build up, making this organ swollen and tender and impairing its function. In the kidney, it reduces the ability to produce urine, causing the body to retain water (especially the lungs) and waste products to build up in the blood. Except in severe cases, these effects disappear after exposure stops, and the liver and kidney begin functioning normally again within a few days or weeks. Eating food or drinking water with high concentrations of carbon tetrachloride can also cause similar effects in the liver and kidney. Eating food with 2,500 parts per million (ppm) carbon tetrachloride can cause mild effects in most people, but they can be severe, even fatal, in individuals such as heavy drinkers whose liver function is already impaired. Its toxicity is also increased by interactions with other chemicals such as ketones (e.g., acetone). Carbon tetrachloride has been shown to increase the frequency of liver tumors in animals given relatively high concentrations by mouth (through a tube) for a long time. Although data indicate it causes liver cancer in animals, we do not know whether it can cause cancer in humans ingesting it in food or water. We also do not know whether it can cause cancer in animals or humans if it is inhaled. On the basis of the animal studies, the Environmental Protection Agency (EPA) identifies carbon tetrachloride as a probable human carcinogen.

What Is the Risk? The EPA has developed toxicity values to estimate the risk of getting cancer or other adverse health effects as a result of inhaling or ingesting carbon tetrachloride *(see box below)*. The toxicity value for estimating the risk of getting cancer is called a slope factor (SF), and the value for the non-cancer effect is called a reference dose (RfD). An SF is an estimate of the chance that a person exposed to the chemical will get cancer from taking in one milligram per kilogram of body weight per day (mg/kg-day), for a lifetime. An RfD is an estimate of the highest dose that can be taken in every day without causing an adverse non-cancer effect. These toxicity values have been developed by studying test animals given relatively high doses over their lifetimes, then adjusting and normalizing those results to a mg/kg-day basis for humans.

Chemical Toxicity Values		
Cancer Risk		**Non-Cancer Effect**
Oral SF	***Inhalation SF***	***Oral RfD***
0.13 per mg/kg-day	0.053 per mg/kg-day	0.0007 mg/kg-day
The RfD for inhaling carbon tetrachloride has been taken to be the same as that developed for ingestion.		

To illustrate how the RfD is applied, a 150-lb person could safely ingest 0.05 mg carbon tetrachloride every day without expecting any adverse effects (2.2 lb = 1 kg, or 1,000 g). In contrast to the RfD, which represents a "safe daily dose" (and so is compared to the amount an individual takes in, as a ratio), the SF is multiplied by the amount taken in to estimate the cancer risk. Using these values, the EPA estimates that a person would have a one-in-a-million chance of developing cancer if they drank about two quarts of water containing 0.3 microgram per liter (µg/L), or inhaled air containing about 0.07 microgram per cubic meter ($\mu g/m^3$) every day for 30 years.

What Are Current Limits for Environmental Releases and Human Exposures? To help track facility releases of carbon tetrachloride to the environment, the Superfund amendments that address emergency planning and community-right-to-know require releases above 10 lb (4.54 kg) to air, water, or land to be reported annually and entered into a nationwide Toxic Release Inventory. For drinking water supplies, EPA has established a protective level (maximum contaminant level) of 5 ppb and recommends that the level not exceed 300 ppb for adults or 70 ppb for children for chronic exposures (more than seven years). For air in the workplace, the Occupational Safety and Health Administration has identified a limit of 10,000 ppb in air for an 8-hour work day over a 40-hour work week.

Where Can I Find More Information? More information can be found in the primary information source used to prepare this overview: the Toxicological Profile for Carbon Tetrachloride prepared by the Agency for Toxic Substances and Disease Registry (ATSDR). Several sources of information are available on the Internet, including the ATSDR ToxFAQS (http://www.atsdr.cdc.gov/toxfaq.html), the EPA Integrated Risk Information System Database (http://www.epa.gov/iris/subst/index.html), and the NLM Hazardous Substance Data Bank (http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB).